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Original article

Prevalence of *Proteus mirabilis* isolated from urinary tract infections among children in Diyala Governorate

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ABSTRACT

Background: Urinary tract infection (UTI) is a bacterial infection of the bladder and associated structures. These are patients with no structural abnormality and no comorbidities, such as diabetes, immunocompromised, or pregnant. Uncomplicated UTI is also known as cystitis or lower UTI. **Methods:** This study was conducted at Al-Batoul Teaching Hospital for Maternity and Children, from May 2023 to March 2024. A total of 280 urine samples were collected according to high-precision standards, ensuring that no antibiotics were taken prior to collection. All samples were cultured on blood agar and MacConkey agar, then incubated at 37°C for 24 hours. Bacteria were identified and susceptibility tested using the Vitek system. **Result:** Twenty-one isolates were obtained out of 280, representing a percentage of 7.5%. The prevalence of bacterial infection was higher among females (80.9%), while it was 19% among males. *P.mirabilis* also showed high resistance to penicillin group (penicillin, piperacillin and amoxicillin-clavulanic acid) at rates of 90.4%, 76.1% and 57.1%, respectively. and Cephalosporin group (Cefepime, Cephotoxime, Cefoxitin, and Ceflazidime) at rates of 76.1%, 71.4%, 66.6%, and 76.1%, respectively. The results also showed slight resistance to fluoroquinolones group (gentamicin, ciprofloxacin, and levofloxacin) with rates of 28.5%, 33.3%, and 4.7%, respectively. However, the results of our study showed the bacteria were sensitive to carbapenems group (meropenem and imipenem) was 95.2% and 80.9%, respectively. And in amikacin was 85.7% within the aminoglycosides group. **Conclusion:** The best treatment for urinary tract infections caused by *Proteus mirabilis* is meropenem, followed by amikacin, and then imipenem

Introduction

Urinary tract infections (UTIs) are among the most common diseases in children , these infections affect between 3% of girls and 1% of boys in childhood, and present symptoms in 7.9% and 1.4% of school-age girls and boys, respectively [1]. UTIs are also more common in uncircumcised males; other risk factors include urinary retention in the bladder, poor genital hygiene, and failure of the bladder's protective mechanisms [2]. UTIs are caused by bacterial colonization of the urethra;

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bacteria typically colonize the urethral opening and then ascend [3]. The most common pathogen causing UTIs is *Escherichia coli*, which causes 85–90% of UTIs, followed by *Klebsiella spp.* and *Proteus mirabilis*, which cause numerous complications, such as kidney stones, catheter obstruction, and kidney damage [4]. The prevalence of urinary tract infections (UTIs) depends on the age and sex of children [5]. In infants, it is greater than in younger children, and 7% among newborns [6]. Risk factors for UTIs in children are limited and are associated with constipation, bladder instability, and fecal incontinence, reflux of urine from the bladder to the ureter is common in children with anatomical abnormalities of the urinary tract [7]. In cases of UTIs, a urethral catheter, a sterile closed system consisting of a tube inserted through the urethra, sometimes used to drain urine [8]. However, many species of bacteria can colonize these catheters and cause catheter-associated UTIs, catheterization and cystoscopy are the two main causative agents of hospital-acquired UTIs in both sexes [9]. Microorganisms can invade and cause UTIs through three main pathways: lymphatic, ascending, and hematogenous, hematogenous spread occurs due to bacteremia [10]. The World Health Organization reported that bacteria causing urinary tract infections are resistant to antibiotics [11]. This study aimed to determine the prevalence of *Proteus mirabilis* among children with urinary tract infections (UTIs) in Diyala Governorate and to identify their susceptibility to antibiotic resistance.

Patients and methods

Sample Collection

A total of 280 urine samples were collected from patients presenting to the hospital's Consulting Clinic with symptoms of urinary tract infections. All samples were collected according to high-precision standards, ensuring that no antibiotics were taken prior to collection. All samples were cultured on blood agar and MacConkey agar, then incubated at 37°C for 24 hours. Bacteria were identified and susceptibility tested using the Vitek system.

Antibiotic Susceptibility Testing:

The AST-N326 plates of the VITEK system were used to determine antibiotic susceptibility, prepared by the American company bioM´erieux Inc. The manufacturer's instructions were followed and the results were interpreted using VITEK 2 software version 08.01. Final results were obtained automatically after 24 hours [12]. Table (1) shows the antibiotics used in the study.

Table (1): The antibiotics used in the study.

Class	type	Sym
Penicillin	Ampicillin	AM
	Piperacillin	PI
	amoxicillin-clavulanic acid	AuG
Cephalosporin	Cefepime	Cpm
	Cephotoxime	CTX
	Cefoxitin	CX
	Ceflazidime	CAZ
Fluoroquinolones	Gentamicin	GM
	Ciprofloxacin	CIP
	Levofloxacin	LEV
carbapenems	Imipenem	IPM
	Meropenem	MRP
Aminoglycosides	Amikacin	AMK

Statistical Analysis:

Calculations were performed for data analysis using Excel 2019, and quantitative data were expressed as frequencies and percentages.

Results and Discussion

Distribution of *P. mirabilis* within the study samples

This study was designed to isolate and determine the prevalence of *Proteus mirabilis* in patients with urinary tract infections (UTIs) and their susceptibility to common antibiotics. This study included 280 children aged 2 to 11 with symptoms of urinary tract infections (UTIs) including fever and dysuria. Microscopic examination results showed that all patients were suffering from urinary tract infection, Tests showed the presence of pus cells, epithelial cells, blood cells, etc. The results of cultures showed that positive *Proteus mirabilis* cultures was 21 out of 280 (7.5%). These bacteria appeared on MacConkey medium as round, medium-sized, pale-colored, non-lactose-fermented colonies with a foul odor.

Figure (2) shows that significantly different between males and females in the incidence of bacterial urinary tract infection by *Proteus Mirabilis*. The prevalence among females was 80.9% (17 females out of 21 cases), while in males was 19 % (4 males out of 21 cases), and the number of female patients residing in urban areas was significantly lower than the infection rates for patients residing in rural areas. These results are similar to those of Ghofran *et al.* [13], who found that the isolation rate of *P. mirabilis* from patients living in semi-urban areas was higher than in urban

areas. These differences may be attributed to differences in social status, the level of education and awareness of parents and personal hygiene, poor health infrastructure in rural areas, and the lack of school health services in most schools, whether in urban or rural communities [14, 15]. Most urinary tract infections in children are caused by bacteria entering the urethra. Girls are more at risk because their urethra is shorter and closer to the rectum [16].

Table (2): Distribution of *P. mirabilis* within the study samples

Child's age	Gender	Mother's education	Residence	No. (%)	No. (%)
2 - 4	uncircumcised male	Secondary	Urban	3 (14.2 %)	4 (19%) **In male**
3 years	circumcised male	Primary	Urban	1 (4.7%)	
3 -11	Female	Secondary	Rural	12 (57.1%)	17 (80.9 %) **In female**
9 - 10	Female	High	Urban	5 (23.8%)	

Pattern of Antibiotic susceptibility of *Proteus mirabilis* isolates.

In table (3), the bacteria showed resistance to the penicillin group used in the study, including penicillin, at a rate of 90.4%, while piperacillin and amoxicillin-clavulanic acid were at rates of 76.1% and 57.1%, respectively.

Table (3): Pattern of Antibiotic susceptibility of *Proteus mirabilis* isolates.

Antibiotic		Sensitive		Resistant	
Class	**type**	**No.**	**%**	**No.**	**%**
Penicillin	Ampicillin	2	9.5	19	90.4
	Piperacillin	5	23.8	16	76.1
	amoxicillin-clavulanic acid	9	42.8	12	57.1
Cephalosporin	Cefepime	5	23.8	16	76.1
	Cephotoxime	6	28.5	15	71.4
	Cefoxitin	7	33.3	14	66.6
	Ceflazidime	5	23.8	16	76.1
Fluoroquinolones	Gentamicin	15	71.4	6	28.5
	Ciprofloxacin	14	66.6	7	33.3
	Levofloxacin	20	95.2	1	4.7
carbapenems	Imipenem	17	80.9	4	19
	Meropenem	20	95.2	1	4.7
Aminoglycosides	Amikacin	18	85.7	3	14.2

In previous studies, researchers reported similar results to the current study [17,18,19]. The bacteria also showed resistance to the Cephalosporin group (Cefepime, Cephotoxime, Cefoxitin, and Ceflazidime) at rates of 76.1%, 71.4%, 66.6%, and 76.1%, respectively. The main reason for the development of resistance in *P. mirabilis* is its ability to produce beta-lactase, which is encoded in the chromosome or plasmid, leading to multidrug resistance. Furthermore, it plays an important role through altered target sites and decreased cell wall permeability [20]. This is due to efflux systems that can expel antibiotics outside the cell [21]. Slight resistance to gentamicin, ciprofloxacin, and levofloxacin was also recorded, with rates of 28.5%, 33.3%, and 4.7%, respectively. One of the most significant challenges facing healthcare professionals is antimicrobial resistance [22]. However, the results of our study showed that the bacteria are sensitive to some drug classes. Sensitivity to imipenem and meropenem was 80.9% and 95.2%, respectively, within the carbapenem group. Sensitivity to amikacin was 85.7% within the aminoglycosides group. Proper control and management strategies are essential to combat this problem, both in terms of preventing the overuse and misuse of antibiotics [23]. Therefore, given these findings, healthcare and educational authorities must redouble their efforts to educate citizens using all possible means. They may also pursue and implement stricter measures to prevent unnecessary prescriptions. [24, 25].

Conclusion:

The best treatment for urinary tract infections caused by *Proteus mirabilis* is meropenem, followed by amikacin, and then imipenem.

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